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Is salinity a factor in the distribution of Nereocystis Luetkeana?[*]

GEORGE B. RIGG

Under an appointment from the United States Bureau of Soils the writer has investigated the kelps of the Puget Sound region as a source of potash fertilizer. This work was done during the summers of 1911 and 1912. During 1912 attention was given in particular to a study of the effect of fresh water on the growth of the bladder kelp (*Nereocystis Luetkeana*) as seen in the bed in Freshwater Bay near the mouth of the Elwha River. The Elwha is a snow-fed stream originating on the southwestern slope of Mount Olympus. It flows north and discharges into the Strait of Juan de Fuca some six miles west of the city of Port Angeles, Washington. It is the largest stream flowing into the Strait of Juan de Fuca or Puget Sound from the Olympic Mountains. The monthly maximum and minimum discharge of this river is reported in the Report of the United States Geological Survey,[†] in cubic feet per second, for the period of October, 1897, to December, 1898. For the portion of the year 1897 covered by this report the maximum discharge occurred in November and was 7,075 second feet, while the minimum occurred in October and was 171 second feet. For 1898 the maximum (3,282 second feet) occurred in June and the minimum (330 second feet) occurred in October. The mean for the period reported is 1,444 second feet. These observations were taken at McDonald, Washington. This is above the outlet of Lake Sutherland and also the outlet of Little River, so that the actual discharge of the river was somewhat greater than the above figures show. Mr. G. W. Northrup, superintendent of the operation of the power plant of the Olympic Power Company on the Elwha, states that the minimum discharge of the river for the year 1912 has been between 400 and 500 second feet, and that the maximum reaches an enormous amount each year during flood water periods, that is, in May and November.

[†] Published by permission of the Secretary of Agriculture.

[*] Twentieth Annual Report of the United States Geological Survey, Part IV, p. 531.

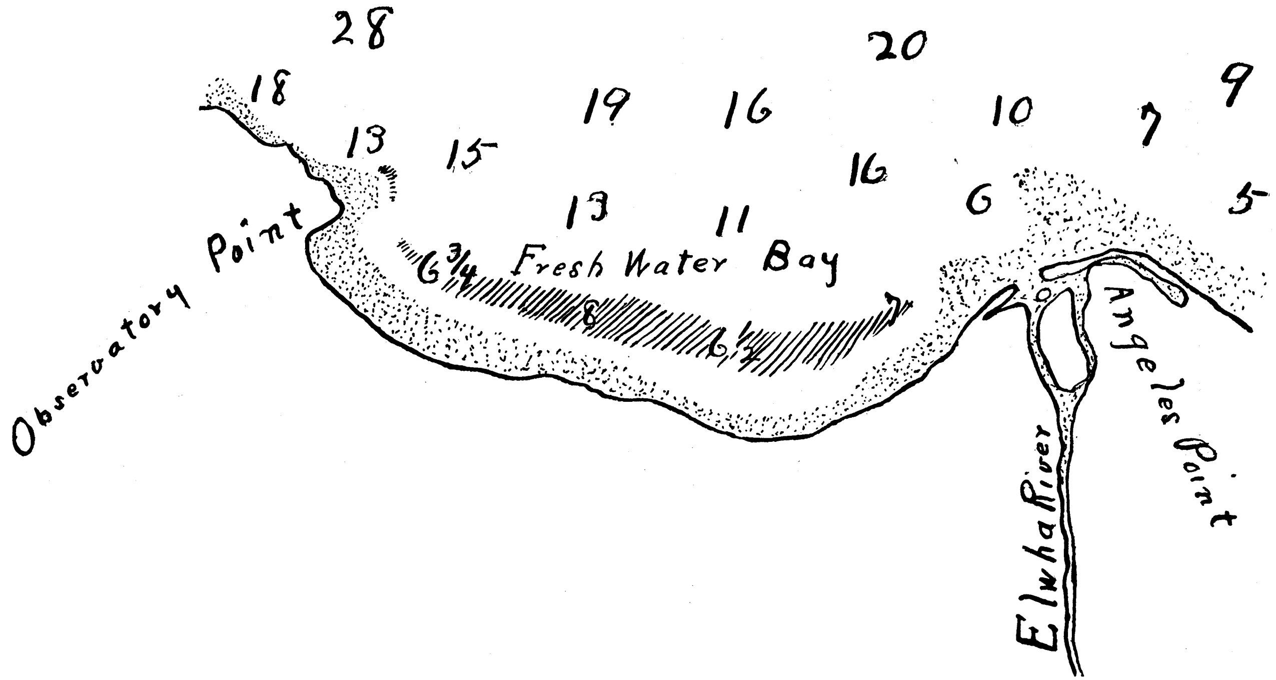

FIG. 1. Map of Freshwater Bay, Washington. Drawn from U. S. Coast and Geodetic Survey Chart no. 6300; kelp bed (*Nereocystis*) shown by ////////; soundings given in fathoms; dotted area indicates shoal water.

Freshwater Bay does not form a harbor. The distance in a straight line from Angeles Point, which marks the eastern side of the bay, to Observatory Point at its western side is four miles, while the maximum distance to shore in the bay, measured at a right angle from the above line, is only one mile. The strong tidal currents flowing in and out through the Strait of Juan de Fuca sweep freely through this bay. There is a good beach along practically the whole bay. The field observations on the kelp beds in this bay were made on September 11 and 12. On September 11, the surf was so heavy that it was deemed impracticable either to enter the mouth of the river in the 50-foot launch in which the trip was made, or to land with a skiff in the more exposed portion of the bay. The launch was anchored in the more protected portion of the bay behind Observatory Point. A landing was readily made with the skiff from this point. On the afternoon of September 12, the water in the bay was much quieter and we entered the mouth of the river in the launch.

There is no kelp at all opposite the mouth of the Elwha River. The river enters the bay by two mouths and the first kelp plants found were about half a mile west of the west mouth. At this end of the bed the kelp plants are scattering and of medium size. A little farther west the bed becomes quite dense, and continues so to a point near Observatory Point. The bed is not closer to the beach than one fourth of a mile at any point. The bed is more than 500 feet wide in places and is over two miles long. There is also a good deal of kelp around Observatory Point. The bladder kelp (*Nereocystis Luetkeana*) is the only kelp found growing in this bed. *Macrocystis pyrifera* was found floating in the bay, but not attached.

Hydrometer readings to determine the density of the water were made at the most eastern point at which kelp was found in the bay, at the west end of the bed, and at several intermediate points. Readings for comparison were made at several points in the open Strait also. A reading was made in the mouth of the river and one at a point about 500 feet directly out from the mouth. All readings were taken at a temperature of 15.5° C., that being the temperature to which the zero point of the instrument used was adjusted. The water of the river proved to be exactly this temperature, while the samples from the kelp bed and the open Strait varied from 12.5° C. to 13.5° C. There was found to be no difference in the hydrometer readings taken in the open Strait and those taken at any of the points where kelp grew in the bay. The reading taken in the mouth of the river was zero. The reading taken about 500 feet straight out from the mouth of the river showed about one third as great a salinity as the water of the Strait and of the bay.

The facts are, then, that a strong tidal current sweeps freely through this kelp bed, and the water at all points in it shows the normal salinity of the water of the Strait. So far as this bed is concerned kelp does not grow in water that has less than the normal salinity. It does not seem quite possible, however, to say positively that the lack of normal salinity is the only inhibiting factor preventing the growth of kelp near the mouth of the river, although it seems to the writer that such is probably the case. Outside of the question of the salinity of the water, there are at least three factors that limit the distribution of *Nereocystis* in the Puget Sound region. These are rocks for anchorage, a strong tidal current, and proper depth of the water. The strong tidal current is present at the mouth of the river, as it is in the other portions of the bay, and the water is of proper depth for kelp, a little distance off shore, as it is in the other portions of the bay, where kelp does thrive abundantly. It may be possible that the silt brought down by the river has so covered the rocks near the mouth of the river as to render the attachment of kelp impossible.

Two sets of samples were collected—one set from the extreme western end of the bed (over three miles from the mouth of the river) and one set from the extreme eastern end (the portion of the bed nearest the mouth of the river). The analysis of these samples is shown in the following table.

The above figures should not be construed as indicating positively any characteristic difference in the potash content of the kelp from the two ends of the bed. It will be noted that sample number 3 has a much higher potash content than any other sample reported in the table. Neglecting this one, the samples from the west end of the bed average about one per cent higher in potash than the samples from the east end. This, however, should be considered in the light of the fact that two samples of fronds collected by the writer in the Brown's Island bed near Friday Harbor, Washington, in 1911, and analyzed by Dr. J. W. Turrentine of the United States Bureau of Soils differed in their potash content by 9.7 per cent.*

COMPOSITION OF KELP SAMPLES (*Nereocystis Luetkeana*) FROM FRESHWATER BAY, PUGET SOUND. Collected by George B. Rigg. Analyses by E. G. Parker and J. R. Lindemuth, U. S. Bureau of Soils. Nitrogen determinations by J. C. Trescott, U. S. Bureau of Chemistry.

No.	Locality	Portion of plant	Potash, per cent.	Nitrogen, per cent.	Iodine, per cent.	Soluble salts, per cent.	Organic matter, per cent.	Ash, per cent.
1	From west end of bay	Fronds	18.04	2.26	0.23	44.17	51.13	4.80
2		Fronds	17.61	2.21	0.24	44.70	51.11	4.72
3		Stipes	31.62	1.21	0.25	63.75	33.15	3.46
4	From east end of bay	Fronds	16.92	2.57	0.20	43.37	51.16	5.47
5		Fronds	17.05	2.71	0.24	41.53	51.67	6.30
6		Fronds	17.32	2.53	0.28	45.40	50.12	4.48
7		Fronds	16.20	2.54	0.19	42.88	52.19	4.98
8		Stipes	16.50	2.21	0.30	59.24	37.40	3.36
9		Stipes	16.72	1.46	0.20	57.06	39.02	3.92

It is quite possible that in some states of tide and current the water may be less saline at the east end of the bed than at the west end, and that this may account for the slightly lower potash content in the samples from the east end.

There seems to have been little previous work done on the influence of the varying salinity of water on the growth of the Laminariaceae. Setchell† says that "Exact figures are wanting" and that "Recourse may be had only to general experience and statements can be couched only in general terms." He says that a few Laminariaceae "ascend tidal rivers to a slight extent." The writer has not found any instance of this in the Puget Sound region, but his investigation particularly of the smaller leaf-like species has not been by any means complete.

Setchell notes the fact that Fucaceae and Ulvaceae are found in tidal rivers. This is true in the Puget Sound region. It is interesting in this connection to note that a *Pelvetia* plant has even been found growing in a salt marsh in this region. The specimen referred to was found by Dr. T. C. Frye in a marsh near Toke Point, Washington.

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* Sixty second Congress, Second Session. Senate Document No. 190, p. 220.

† Ibid., p. 135.

While the writer has not made any detailed investigations in regard to the growth of Laminariaceae near the mouth of any other river than the Elwha, his general observations as well as his conversations and correspondence with other observers lead him to believe that kelps are to be looked for in this region only where the water has practically the normal salinity of sea water.

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